

# **Electroconvulsive Therapy Workshop**

## **ECT: A Core Review of Current Practice**



Canadian Psychiatric Association  
Association des psychiatres du Canada

**Ottawa**  
**27 September 2013**

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# **ECT: Technique and Equipment**

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No disclosures to declare.



# CPA Kiosk / Kiosque de l'APC



<http://ilinks.info/kiosk>

## 63<sup>rd</sup> Canadian Psychiatric Association's Annual Conference

ICALENDAR / SEARCH ENGINE

INDIVIDUAL SESSION EVALUATIONS

OVERALL CONFERENCE EVALUATION

CERTIFICATE OF ATTENDANCE

## Le 63<sup>e</sup> congrès annuel de l'Association des psychiatres du Canada

ICALENDAR/MOTEUR DE RECHERCHE

ÉVALUATIONS DE CHAQUE SÉANCE

L'ÉVALUATION GLOBALE DU CONGRÈS

CERTIFICAT DE PRÉSENCE



Canadian Psychiatric Association  
Association des psychiatres du Canada

# The Art of ECT

- Ensure medical safety
- Minimize cognitive adverse effects
- Optimize symptom reduction



# Seizure

A rhythmic and repeated discharge (depolarization) of brain cells in unison.

Initiated when a “pacemaker” area of the brain is activated, begins firing and seizure activity is propagated throughout the brain via neuronal projections.



# Seizure Threshold

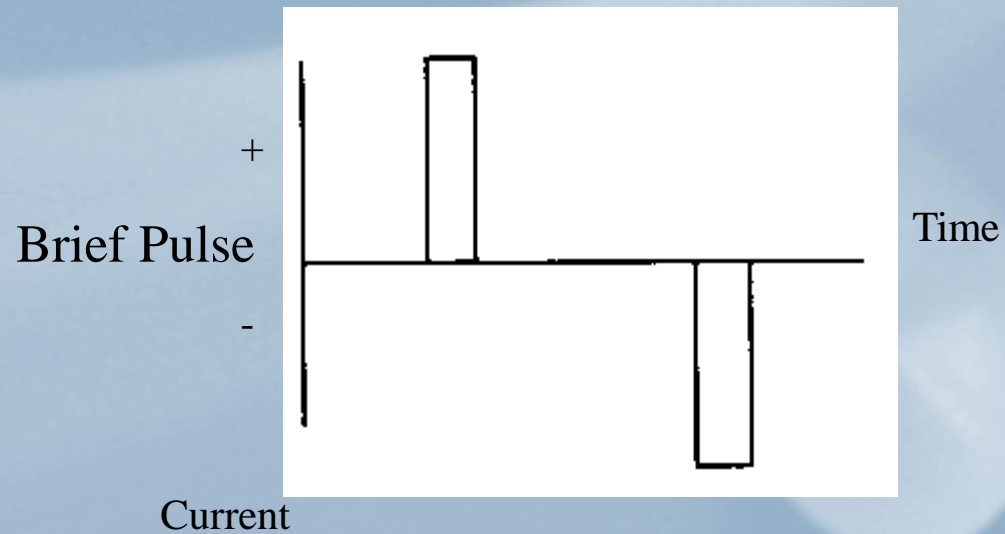
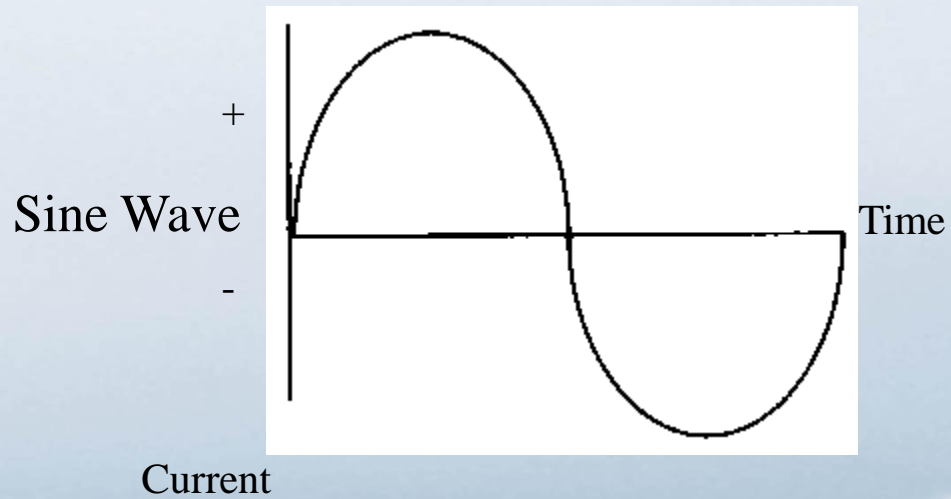
*Sufficient* neurons must be depolarized in order to create the excitatory process in the brainstem

Therefore, via the ECT device, we deliver “tiny doses of current to the scalp, repeatedly, pulse by pulse, until that critical point has been reached and a seizure ensues”

- Abrams



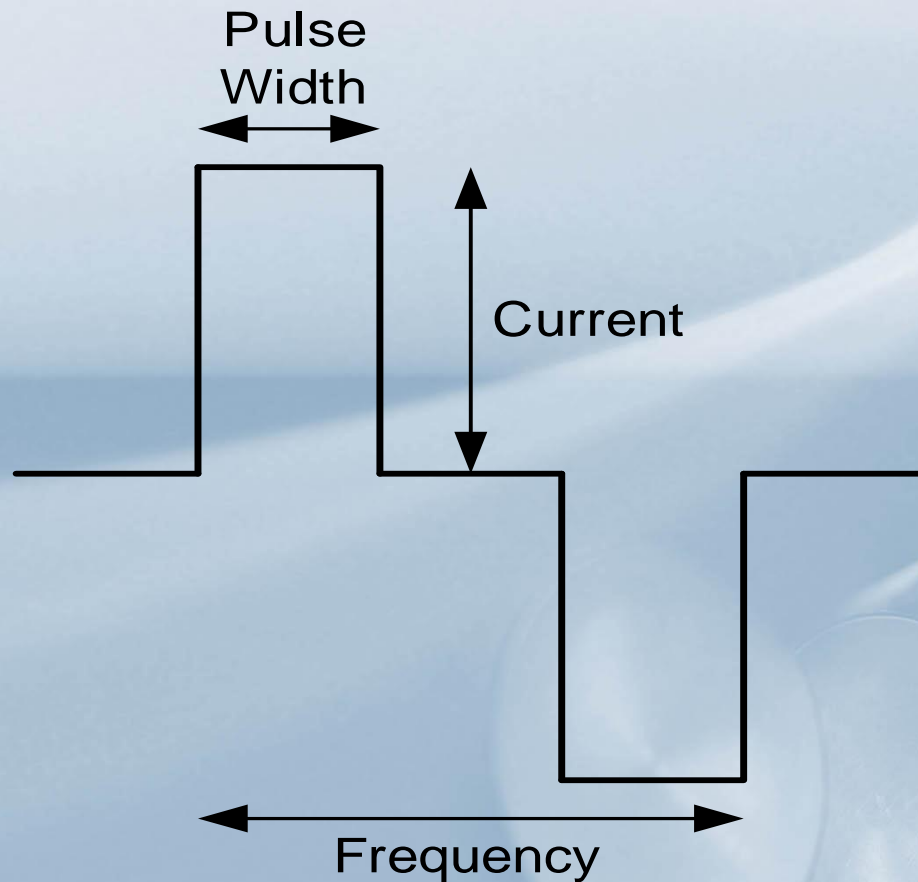
# ECT Waveform Types





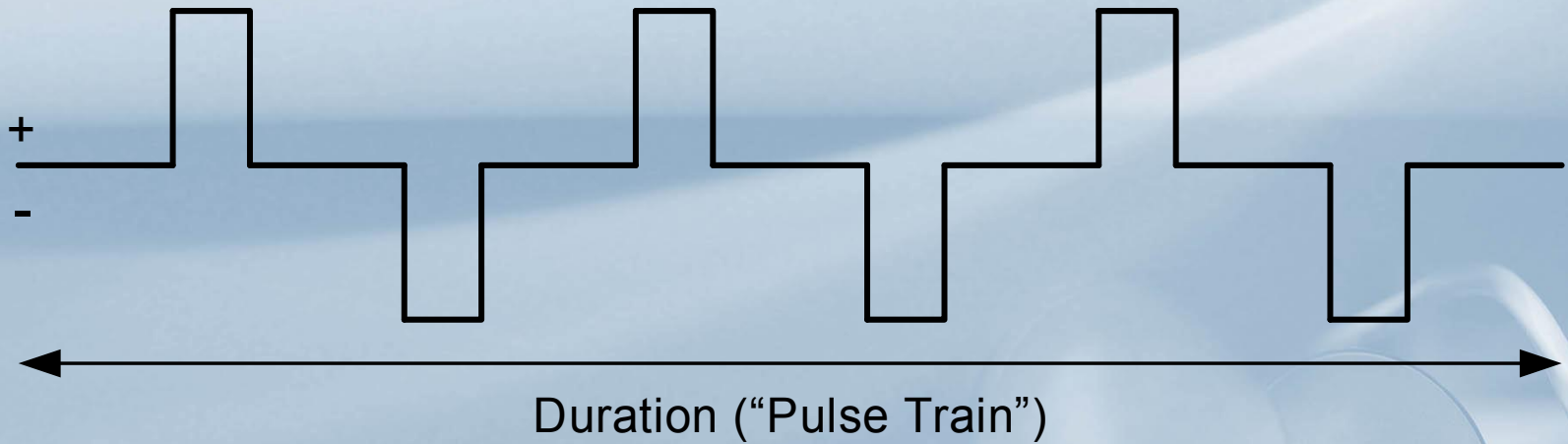
# Modern ECT Devices

Brief Pulse Device



# Modern ECT Devices

Brief Pulse Device



# Impedance

Impedance = resistivity + capacitance

Capacitance = the property of being able to *accumulate charge*

Resistivity:

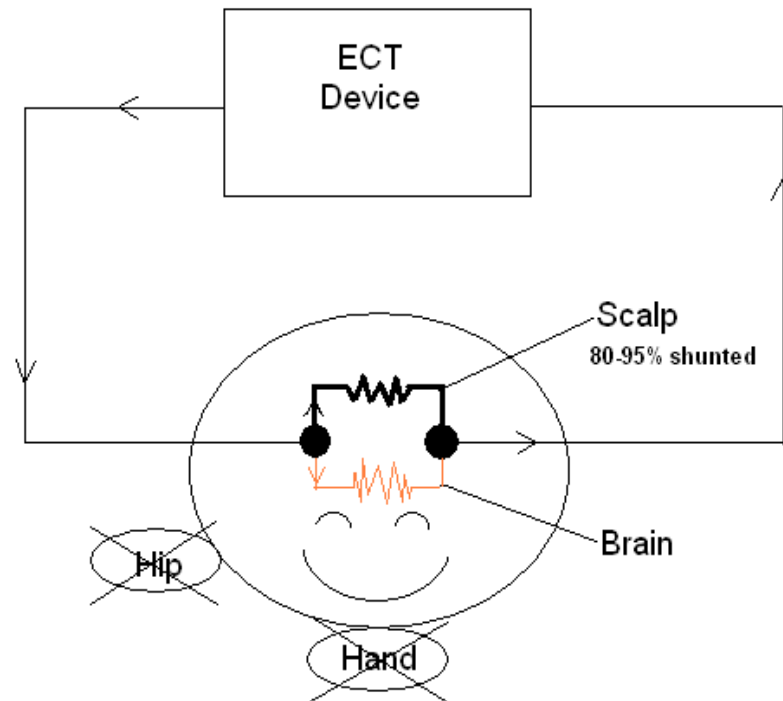
CSF:	65 ohms/cm	(Geddes & Baker, 1967)
scalp + brain:	220 ohms/cm	(Rush & Driscoll, 1968 and 1970)
skull:	17,760 ohms/cm	(Driscoll, 1970)

*Result:*

80 – 95% current is resisted by the skull and shunted through the scalp

**i.e. only 10 – 20% charge delivered by the ECT device enters the brain**

# Electrical Current Path



# Electrode-scalp Interface

*Affected by:*

Electrode size: (smaller → higher impedance) North America's are 5.1 cm<sup>2</sup>

Skin preparation: (solvent + abrasive procedure + conducting gel are required)

NB: hairspray, hair gels, perspiration are *conductant* and short out electrodes in UL ECT

Therefore: **Factors which increase resistance of the scalp lessen the amount of current which accesses the brain even further**

# Electrode Placements in ECT

Bitemporal

Right (or left) unilateral

Bifrontal



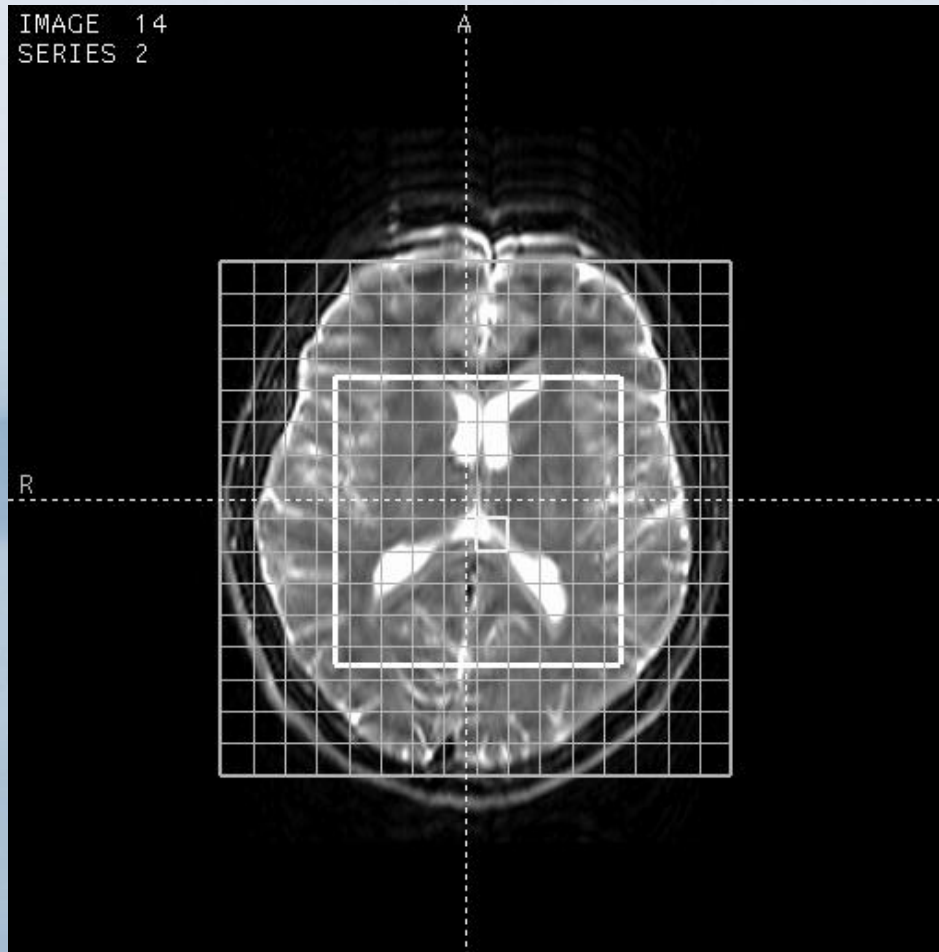


Weaver, Williams and Rush  
1975 Biological Psychiatry

Current Density in Bilateral and Unilateral ECT

Grid: 1154 1-cm<sup>3</sup> volumes; calculated current density of each

# Current Density





## Findings: Unilateral Electrode Placement

1. Current densities are greatest directly underneath the electrodes

and

2. In the cortex along the inter-electrode axis

## Unilateral Electrode Placement (cont'd)

### 3. 1986 Mukherjee & Sackeim:

- variability exists in the excitability of the brain
- i.e. the motor strip has the lowest intrinsic seizure threshold

Theoretically → unilateral ECT should require a lower dose than bilateral ECT

# The influence of electrode placement on electrical current:

*But:* Unilateral (UL) electrodes are closer together than bitemporal electrodes → increased shunting through the scalp results  
ie: a 1/3 decrease of overall current density

D'Elia position = the preferred UL placement to maximize inter-electrode distance

## Findings: Bilateral Electrode Placement

1. Current is diffused through all areas of the brain
2. The bilateral placement induces a significantly higher current density in almost all areas of the brain than RUL
3. Current density is greatest directly underneath the electrodes and
4. Current density is next greatest in the frontal lobes anterior to the interelectrode axis

# Left Unilateral ECT

1968-1970:

6 studies all conclude RUL>LUL

Bad reputation results

*BUT:* Sinewave devices, non-d'Elia positions

1989: Abrams, R.

30 depressed Veterans

Ham-D after ECT #3 & #6: excellent recovery

# Left Unilateral ECT

Current recommendations:

Patients requiring minimal right hemispheric dysfunction

- musicians
- artists
- architects
- chess players
- rt-sided CVA or skull defects
- astronomers

# Bifrontal Electrode Placement

1969 J. Inglis

1972 Abrams/Fink

Goal: Avoid hippocampal gyri

Abrams: electrodes 2" apart, daily ECT, sine wave device

Result:     - skin burns  
              - little benefit over UL

→ abandoned





# Bifrontal Electrodes

Letemendia 1993

5 cm. above outer corner of eye on a sagittal plane

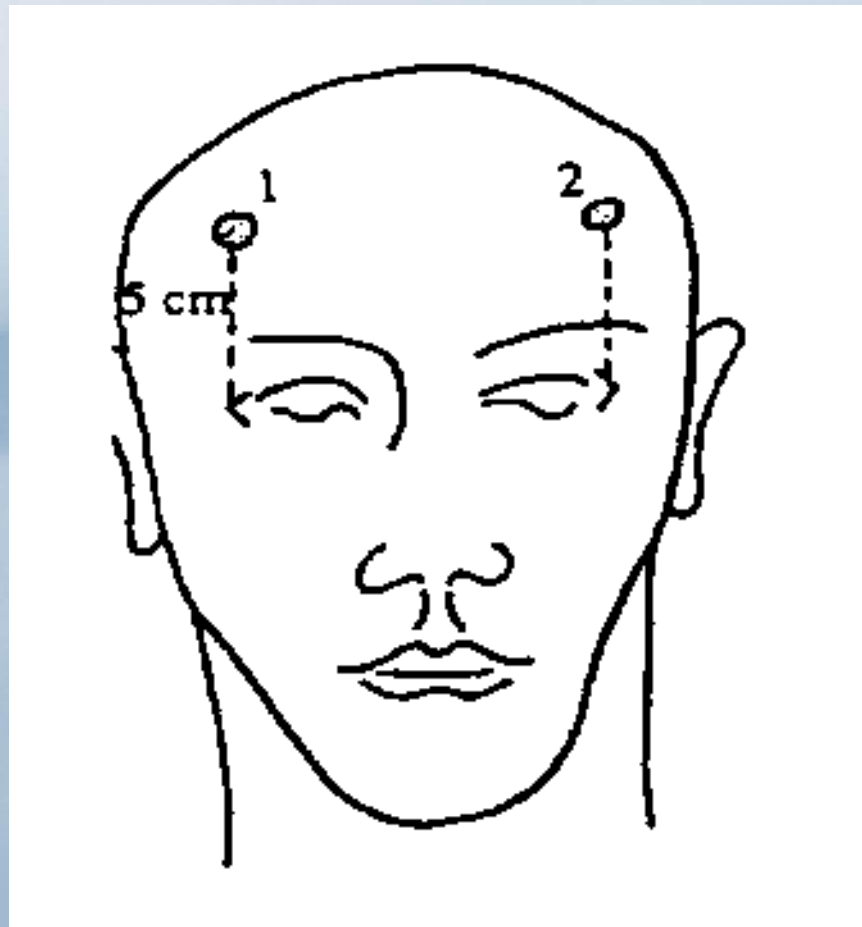
Bailine 2000

Delva 2001





## Bifrontal Electrode Placement

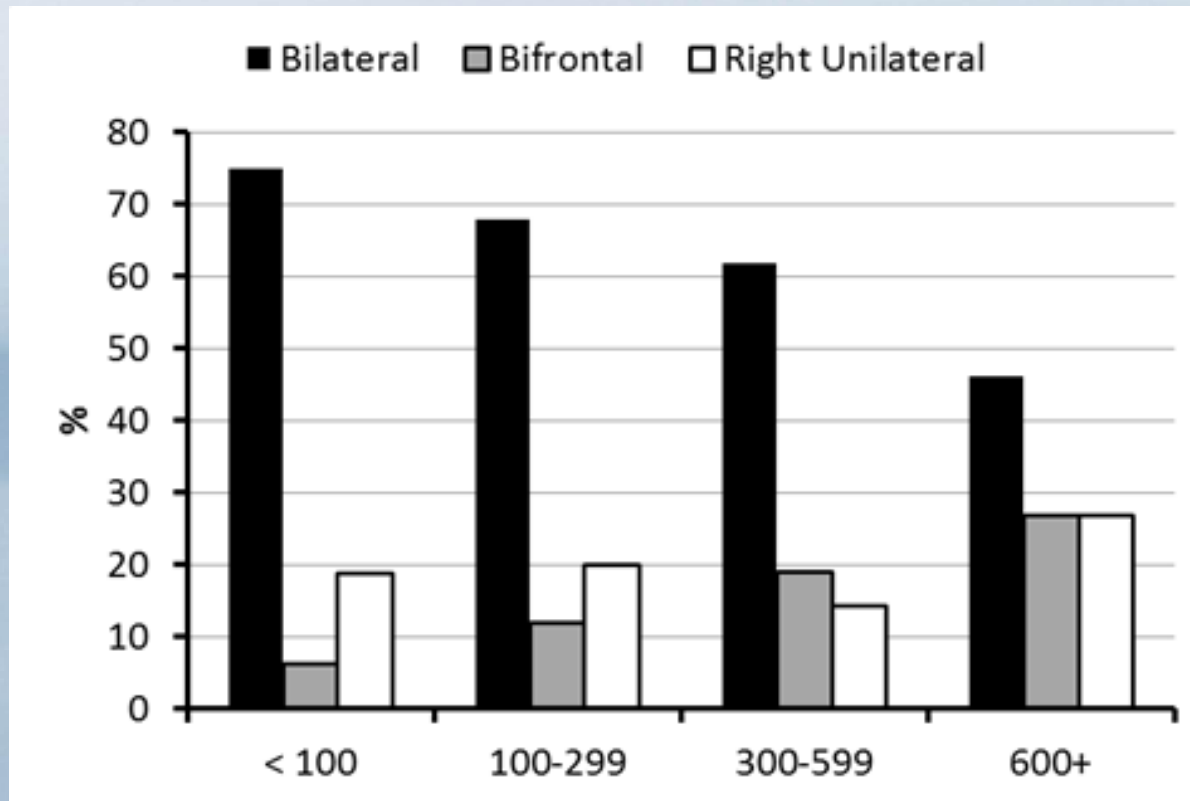


From: Lawson, Inglis, Delva  
et al, 1990

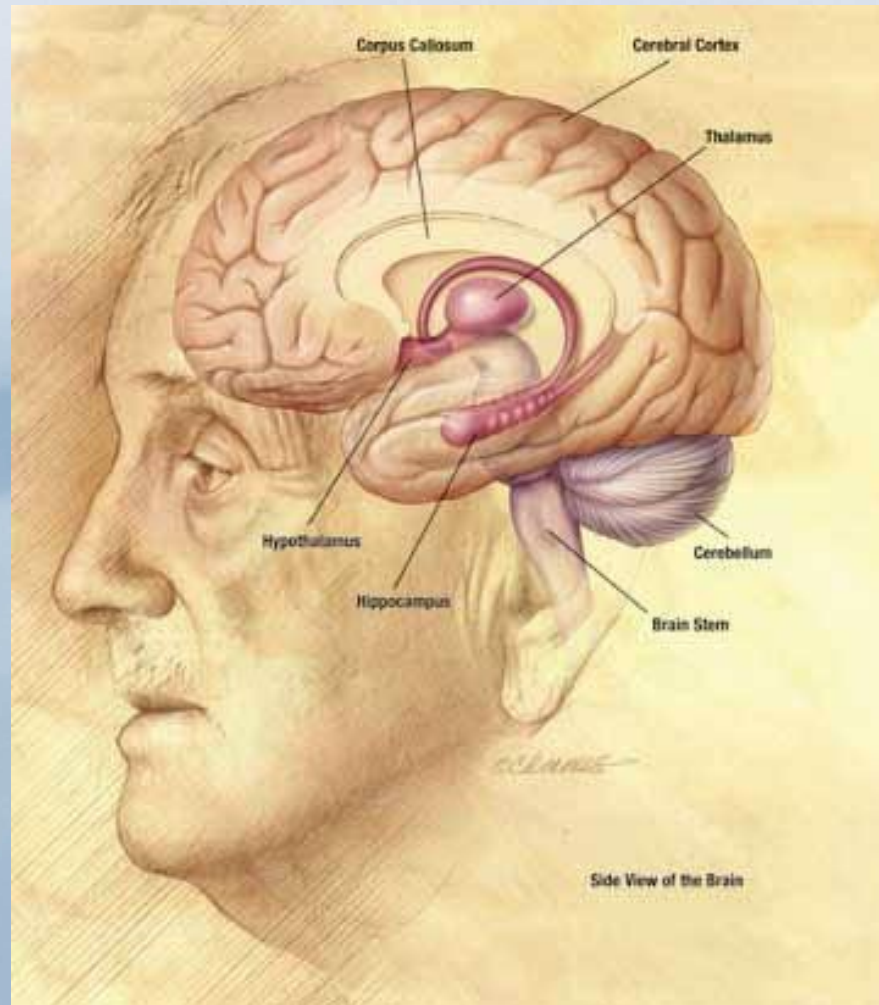
Psych Med (20); 335-344

## CANECTS/ECANEC 2008

Preferred electrode placement according to number of treatments per year



Clinical Application:  
Does where we place electrodes impact cognition and degree of benefit?



# Seizure Threshold in ECT

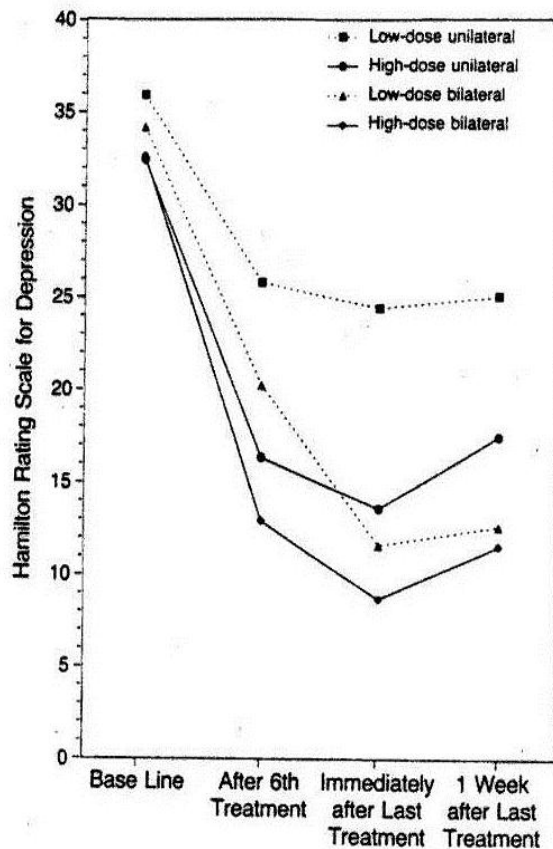


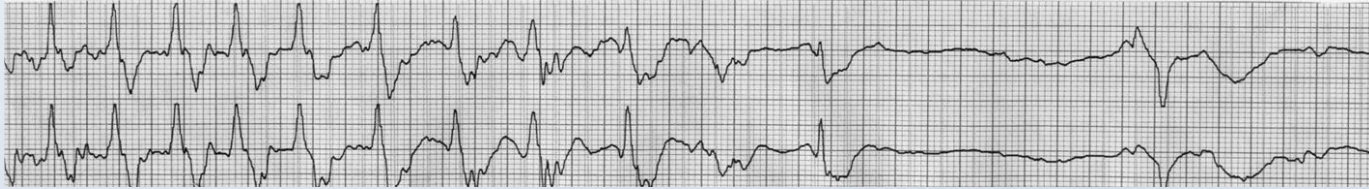
Figure 1. Mean Scores on the Hamilton Rating Scale for Depression at Base Line, after Six Treatments, Immediately after the Last Treatment, and One Week after the Last Treatment in the Four Groups.

N EngJ Med 1993. Sackeim, Prudic, Devanand et al.

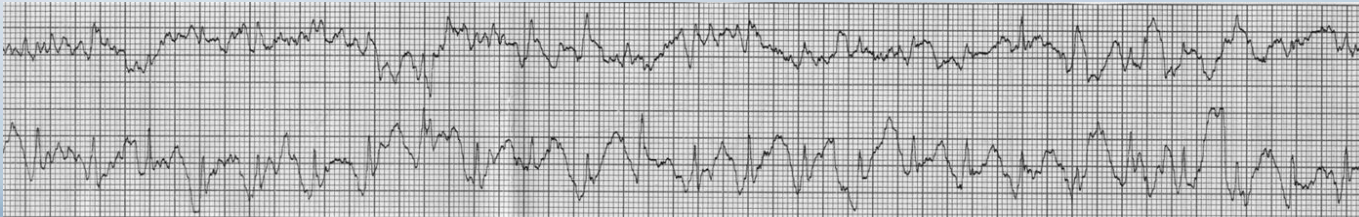


## Seizure Threshold in ECT

**B.**

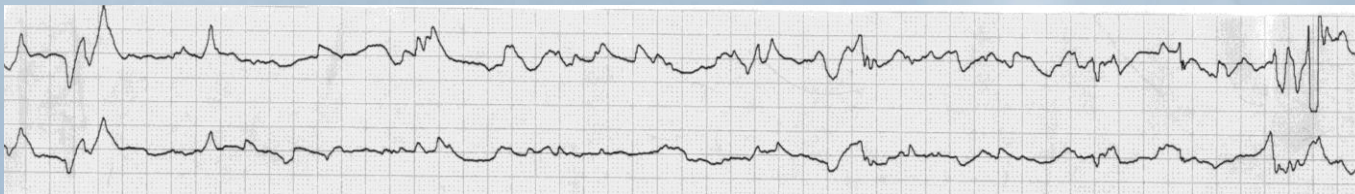


**A.**



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**seizure threshold**



# Schools of Dosing Protocols

- Titration Method
- Half age-based
- Fixed high dose RUL



# ECT Dosing Strategies

## ➤ Titration Method

### ECT # 1: “Finding” Seizure Threshold

- Stimulate with a low electrical test dose (sub convulsive for majority of patients)
- If no seizure results, ***under the same anesthetic***, restimulate at a higher dose until a seizure is obtained - up to 4 stimuli: 3 is usual

*Sackeim, Decina, Kanzler, 1987*

## Titration Method (Cont'd)

ECT #2: if necessary continue to restimulate at higher doses until a seizure ensues

Various dosing protocols are available to select increasing doses from, to avoid the Gestalt method

*In general:*

For BF & BL ECT: increase by 1.5-2.0 X threshold

For UL ECT: increase by 2.5-6.0 X threshold



## 1.5X seizure threshold dosing table

**Table 5-6.** Dose titration techniques for MECTA SpECTrum models (ultra-brief-pulse stimuli)

Dose level	MECTA SpECTrum 4000Q/5000Q					MECTA SpECTrum 4000M/5000M	
	PW (msec)	F (/sec)	D (sec)	I (amp)	Charge (mcoul)	Stimulus level <sup>a</sup> (%)	Charge (mcoul)
1 <sup>b</sup>	0.3	20	2.0	0.8	20	3	17
2 <sup>c</sup>	0.3	30	2.0	0.8	29	5	29
3 <sup>d</sup>	0.3	40	2.5	0.8	48	8	46
4	0.3	50	3.0	0.8	72	13	75
5	0.3	50	4.5	0.8	108	20	115
6	0.3	60	6.0	0.8	173	30	173
7	0.3	90	6.0	0.8	259	45	259
8	0.3	100	8.0	0.8	384	70	403
9	0.37	120	8.0	0.8	568	100	576

*Note.* amp = amperes; mcoul = millicoulombs; msec = milliseconds; sec = seconds; /sec = Hertz.

<sup>a</sup>Percent of maximum output charge.

<sup>b</sup>Start at dose level 1 for unilateral ECT in female patients.

<sup>c</sup>Start at dose level 2 for bilateral ECT in female patients or unilateral ECT in male patients.

<sup>d</sup>Start at dose level 3 for bilateral ECT in male patients.

## Titration Method (Cont'd)

ECT #3 → Onwards

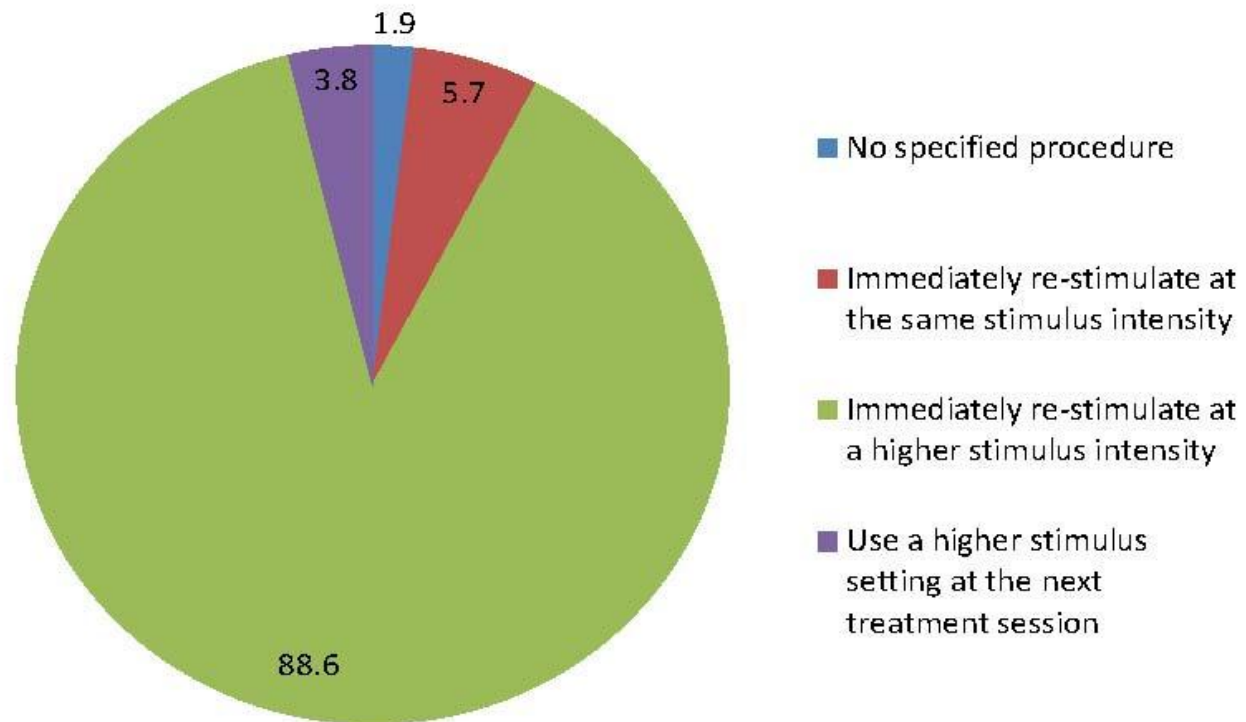
Maintain same dose, or gradually increase using:

1. EEG morphology AND
2. Clinical response

as a guide.



6.12 If the ECT electrical stimulus results in **no** seizure activity, what procedure is **usually** followed at your facility? (check one only)



# ECT “Adequacy”

A. Clinical response

B. EEG Morphology

1. High Amplitude

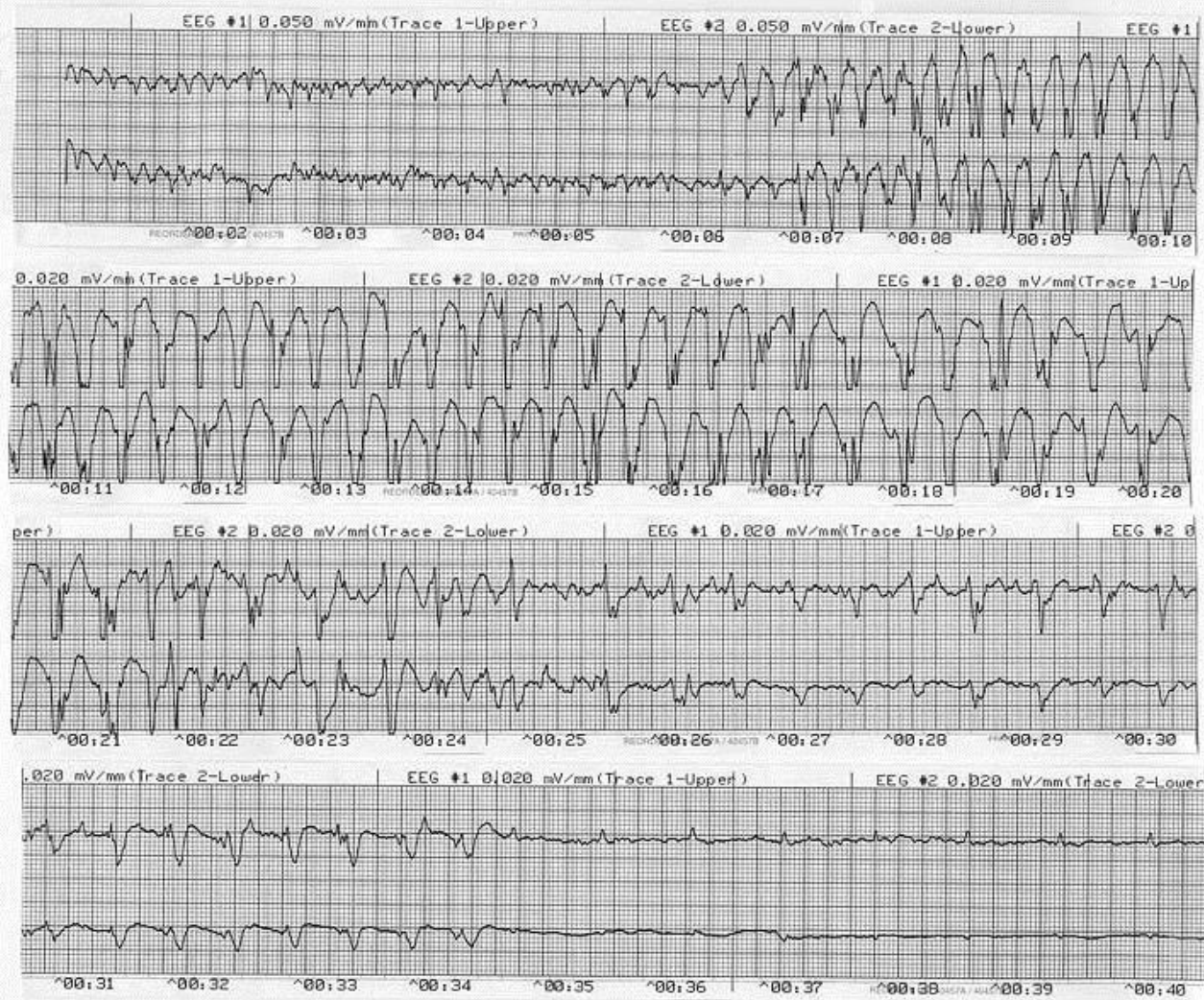
2. Presence of polyspike and slow wave activity  
= Delta Waves

3. Interhemispheric ictal coherence = “symmetry”

4. Sharp and sustained post-ictal suppression

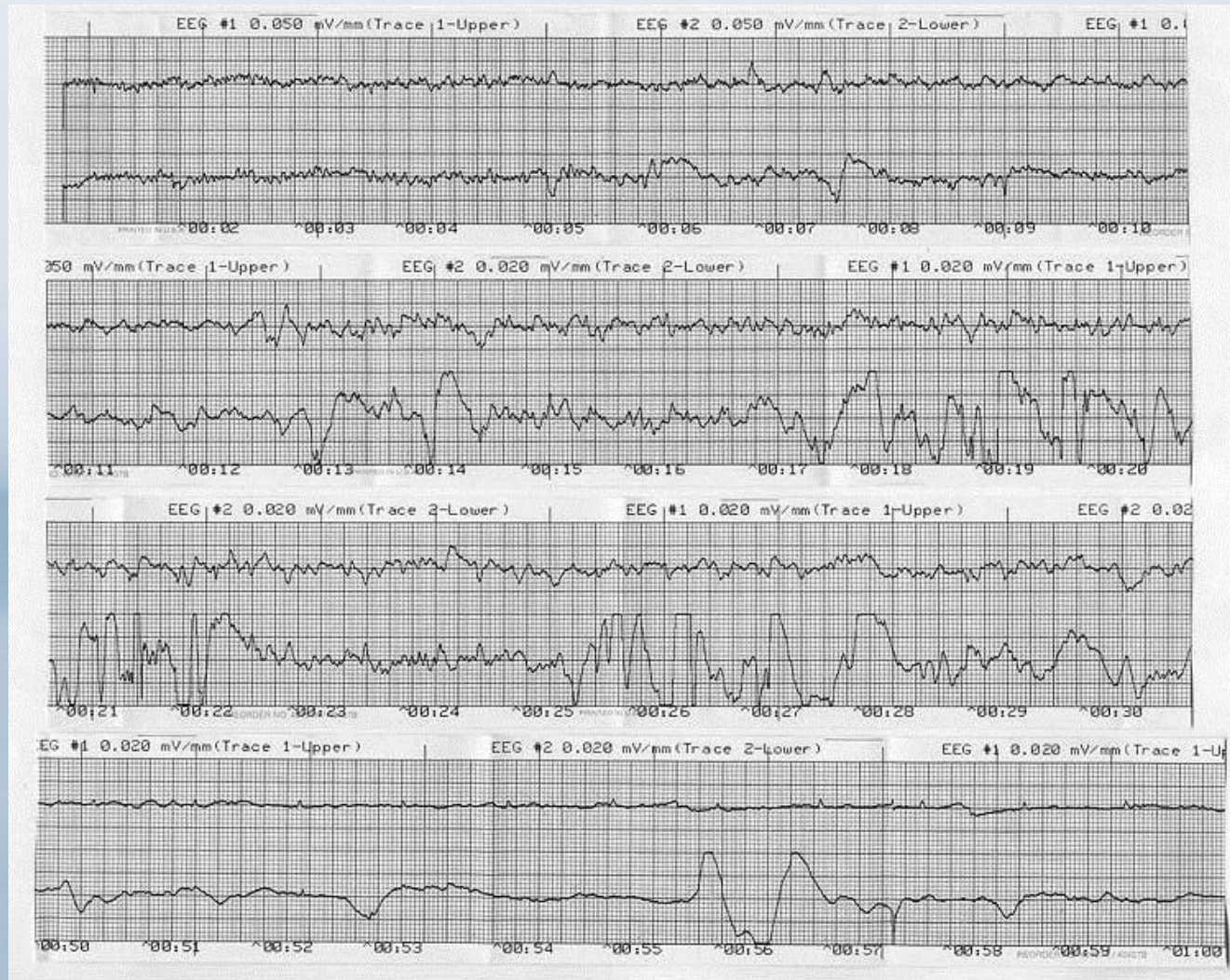


# EEG 1





# EEG 2



## ECT Dosing Strategies (Cont'd)

- Fixed High-Dose Right Unilateral

All ECT at maximum capacity  
0.25-0.5 ms pulse width  
8 sec. pulse train

If no improvement, switch to Bilateral ECT

– *Abrams 2002*

# ECT Dosing Strategies (cont'd)

## ➤ The Half-Age Method

- Bilateral ECT
- Twice Weekly
- Starting dose = energy level of  $\frac{1}{2}$  patient's age  
e.g.: Age 60- start at 30% of the maximum output deliverable by the device.

- *Petrides, Fink 1996*



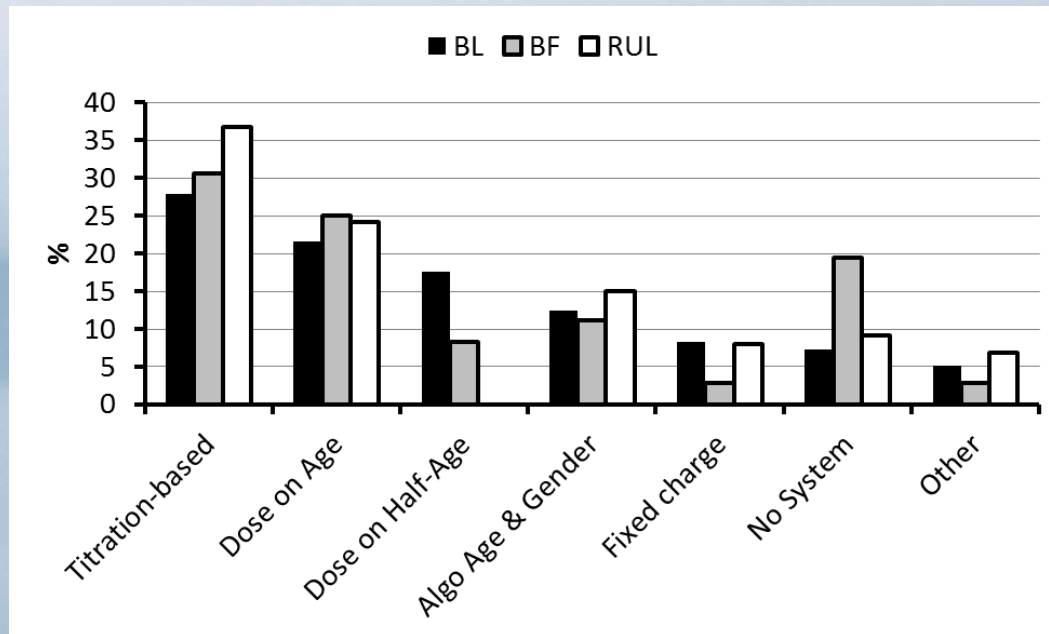
# Schools of Dosing Protocols: Concerns

- Titration: sub-threshold stimuli may bear risk (parasympathetic response)
  
- The Age-based method:
  - seizure threshold (ST) varies from 36 to 869 mC (24-fold) yet
  - age accounts for only 17% of the variability (Boylan L) therefore
  
  - risk of treating with unnecessarily high stimuli in patients with low ST and visa versa

## General Agreement Exists:

- Patients respond faster to BT ECT than RUL ECT
- Patients who do not respond to RUL ECT may undergo a significant clinical improvement with BT ECT
- BT ECT results in greater cognitive SE than RUL ECT
- Relative stimulus intensity – but *not* absolute stimulus intensity is a significant predictor of response

## Basis for choosing treatment intensity of the 1st stimulus for bilateral (BL), bifrontal (BF) and right unilateral (RUL) electrode placements



- ❖ Simply creating a seizure is not good enough
- ❖ Seizure length is not a measure of seizure adequacy



# Missed or Aborted Seizures

## Possible Causes:

- excessive impedance from poor skin contact
- stimulating electrodes not screwed in firmly enough
- hypercarbia from inadequate ventilation
- hypoxia from inadequate ventilation
- dehydration
- medications (benzodiazepines, anticonvulsants)
- insufficient stimulus



# Missed or Aborted Seizures (cont'd)

correct above measures

missed:

- restimulate after 20 sec at a higher dose

aborted:

- restimulate after 45 sec at a higher dose to allow repolarization
- caffeine sodium benzoate 500-2000 mg. po 1 hour pre-ECT with 50cc H2O
- **flumazenil** 0.2 - 0.4 mg. I.V. (max. 1 mg.)
  - if high dose benzodiazepines
  - midazolam in P.A.R. to prevent withdrawal
  - **LIFE SAVING**

*Bailine 1994; Krystal 1998*

# Monitoring Seizures

## EEG

## Ictal Motor Activity

### ➤ Cuff Method

- Prior to succinylcholine, inflate cuff above ankle to 100 mm Hg above Systolic B.P.

### ➤ Peripheral nerve stimulator

- Takes the guesswork out of finding the Point of Maximum Relaxation (PMR)    Average: 90 seconds
- Essential for patients with
  - Osteoporosis
  - Slowed circulation time
  - Co-existent fractures (e.g: post-suicide attempt)

# Elements of ECT Technique

- ❖ Skin Preparation
- ❖ Mouth guard & non-conducting jaw support
- ❖ Rails down, footboards off
- ❖ Peripheral nerve stimulator +/-
- ❖ Pre-oxygenation
- ❖ Optimize electrode-to-scalp contact

